Zastosowanie zaprezentowanej koncepcja integracji narzędzi umożliwiło usprawnienie procesu oceny energetycznej systemu zaopatrzenia w wodę. Korzystając z ogólnego schematu opracowano narzędzie informatyczne, oparte na wolnym oprogramowania do celu oceny energetycznej systemu zaopatrzenia w wodę. Narzędzie rozszerza możliwości obliczania wartości wskaźników efektywności energetycznej wybranych podsystemów lub sektorów obsługiwanych przez te układy, ułatwia śledzenia zmian wskaźników w czasie, ich porównywanie oraz ocenę. Wartością dodaną jest możliwość stosowania matematycznych modeli sieci wodociągowych. Modelowania umożliwia obliczania przepływów oraz wartości dyssypacji energii w każdy z elementów. Analiza taka pozwala na porównywanie różnych scenariuszów rozwoju lub rehabilitacji systemu z punktu widzenia oceny energetycznej. Z wykorzystaniem modeli można również określić maksymalny potencjalny zysk z modernizacji.

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THE REASONABILITY OF USING POWDERED MINERAL MATERIALS IN AEROBIC GRANULAR SLUDGE TECHNOLOGY

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Aside from activated sludge and biofilm, aerobic granular sludge (AGS) represents a third form by which microbial aggregation takes place in the context of wastewater treatment. Aerobic granular sludge technology is a relatively new alternative to the activated sludge method [1]. Compact structure, a high settling capacity, tolerance to high organic load and a potential to remove carbon, nitrogen and phosphorus compounds simultaneously are all major advantages of this technology [1, 2]. In order to intensify of AGS technology, a new biogranulation methods and stability improvement of aerobic granules are sought. The research to intensify this technology were carried out with the use of: chemical coagulants, dosage of granules fragments, powdered sewage sludge as well as powdered materials (mineral and of organic origin) [3, 4]. In activated sludge technology, powdered mineral materials can fulfill different yet complementary functions: as ballast of sludge flocs that improves their structure and properties, as sorbent of chemical substances found in wastewater and as microcarrier of biological membrane [3, 5]. On the other hand, published references indicate that powdered materials also have a positive impact on biogranulation of aerobic granules. The use of such materials gives possibility of microorganisms aggregation acceleration and formation of mature granules in a short time (materials play a role of nucleus which induces aggregation of microorganisms) as well as improvement of sedimentation properties of obtained granules [6, 7].

The own research was conducted in laboratory scale (89 days) in four identical granular sequencing batch reactors (GSBR-s) of 3.0 dm^3 working volume each (Fig. 1). Reactor R1 was a reference system. Powdered mineral materials (Table 1) were supplied to R2, R3 and R4 reactors (one material to one reactor). The reactors operated on successive 3-hour cycles with a volumetric exchange ratio of 50%, resulting in a hydraulic retention time of 6 h. The inoculum was activated sludge (SVI_{30} = 135.2 cm^3/g, MLSS = 6.40 g/dm^3). The volume of inoculum was 60% of the working volume of the reactor. In the research, synthetic wastewater was used and glucose was a source of organic compounds.

Fig. 1. The test system in the laboratory

Table 1. Characteristic of powdered mineral materials (PMM)

Material	Dosage	Granulation d_{90}, d_{50} and d_{10} [μm]	Chemical composition [%]
PMM1	3.0 g/dm^3 was applied to reactor R2	85.279 24.110 3.643	SiO_2: 46.28 Al_2O_3: 17.56 Fe_2O_3: 12.91 CaO: 10.62 MgO: 3.59
PMM2	3.0 g/dm^3 was applied to reactor R3	100.470 26.817 3.194	SiO_2: 69.81 Al_2O_3: 13.84 Fe_2O_3: 2.94 CaO: 1.94 MgO: 0.24
PMM3	3.0 g/dm^3 was applied to reactor R4	189.720 33.915 1.865	SiO_2: 1.19 Al_2O_3: 0.41 Fe_2O_3: 0.48 CaO: 96.69 MgO: 0.76

The results of the research showed that powdered materials have a positive impact on the biogranulation process and that granules could not be formed in reactor without powdered material. This process was different in each reactor. On the last day of the research, mean size of granules was 200.2 μm in the control reactor. In turn in reactors with materials this value amounted to 783.1 μm, 399.0 μm and 430.0 μm, respectively in R2, R3 and R4. Complete granulation was achieved in GSBR-s to which either PMM1 or PMM3 were added. The use of powdered materials had a positive impact on the sedimentation properties of the sludge. The average SVI_{30} (sludge volume index at 30 min) values in the reactors with powdered materials were 39.8 cm^3/g, 55.3 cm^3/g and 32.8 cm^3/g, respectively in R2, R3 and R4. In turn in control reactor this value was 96.6 cm^3/g. The application of powdered mineral materials acted to increase settling velocity too. The average values of this parameter were 15.4 m/h, 10.7 m/h and 13.1 m/h for the R2, R3 and R4 reactors respectively. In these reactors this parameter was much higher than the settling velocity of sludge flocs in reactor R1 (4.0 m/h). On the early days of research, a lower wash out level of the biomass and a higher concentration of the biomass were observed in reactors with powdered materials. The average values for MLSS (mixed liquor suspended solids) were 2.28 g/dm^3, 5.24 g/dm^3, 4.46 g/dm^3 and 5.07 g/dm^3 for the R1, R2, R3 and R4 reactors respectively. In addition, material PMM1 was also microcarrier of granule-forming biomass, which was not observed for PMM2 and PMM3 materials.

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INCREASING THE SENSITIVITY OF METHOD FOR PATHOGEN DETECTION IN WATER BASED ON THE SURFACE PLASMON RESONANCE PHENOMENON

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Introduction. One of the biggest global problem is an unsatisfactory condition of water sources and insufficient sanitation, which are responsible for 90% of lethal cases caused by diarrheal diseases all over the world. It is well known, that bacteria are the main causative agent of diarrhea. However, a wide range of viruses that could be found in water sources have a negative impact on human health and cause a number of clinical symptoms of varying severity in human and animals, from pulmonary fever to brain damage [1]. Existing methods of water quality control are long-lasting and require a special valuable equipment and additional reagents. As an alternative and one of the promising could be a method based on the phenomenon of surface plasmon resonance (SPR), that allows to make an express analyzes (duration less than 1 hour) and does not require specific reagents [2]. The principle of pathogen detection by SPR-methodology based on the determination of the SPR-shift whilst an interaction between receptor and analyte (in our case – antigen and antibody) on the surface of sensitive element of SPR-sensor. This procedure requires a washing of sensitive element after interaction to remove analyte, that was not interact with receptor. In addition, it requires to block gaps without receptor on the sensitive element surface to reduce a non-specific interaction, which increase the measurement errors and subsequently decreased the accuracy of results.